Dental Radiography Study Guide

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This document provides guidance to students and dentists participating in the On-the Job Training Program to help them plan and conduct the required training.

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Dental Radiography Study Guide

Introduction

The Indiana State Department of Health, in compliance with IC 16-41-35, requires that all persons who operate ionizing radiation emitting equipment, which is used for human treatment, be certified. To get this certification in the category of Dental Radiography, you must first complete the Department approved On-the-Job Training (OJT) Program, and then pass the Dental Assiting National Board's (DANB) Dental Radiation Health and Safety Examination. This syllabus has been prepared as a guide to help On-the-Job training students in their studies. This publication is not intended to be complete. As part of the conditions of the OJT program, your supervising dentist is responsible to ensure that you receive the minimum amount of hours of formalized training in the required subjects. This document can serve as a guide to you and your dentist in structuring that training. Other personnel in the dental office--the dental hygienist or certified dental assistant--may be able to help you by answering your questions. Remember that the effort you put into your studies will help you in successfully taking the radiology certification examination.

Enclosed with this book you should have received a document entitled "Suggested Study Materials." These sources might be useful to you and your supervising dentist as you plan and conduct the OJT Program. It may be that you have other radiology informational sources available to you. It will be to your advantage to use them in conjunction with those recommended. A one-day course is no substitute for a 40 clock-hour lecture, demonstration and clinic participation program. The individual who plans to take the DANB Dental Radiation Health and Safety examination is well advised to:

1. Participate in a radiology program which is offered through a dental continuing education program.
2. Thoroughly study the radiology syllabus provided.
3. Study as much of the suggested resources as you can.

General Objectives

Upon completion of dental radiology lecture and clinical training, the dental auxiliary should be able to:

1. **Practice radiation safety measures in treating patients that are required by legal and ethical standards.**
2. **Accurately expose, process, evaluate for quality, mount and file radiographs taken in dental practice.**
3. **Produce films with sufficient density, definition and contrast to be diagnostic to the dentist.**
4. **Demonstrate a working knowledge of the nature of radiation and its relationship to radiation safety.**

Introduction and Historical Background of Dental Radiology

Objectives

1. List the qualities of a good diagnostic radiograph.

2. Define the term radiography.

3. Name the scientist historically recognized as the discoverer of x-rays and supply the date of the discovery.

4. Name three pioneers of dental radiography and what contribution they made to the field.

5. Name the radiology pioneer who first introduced dental radiology into dental curriculum at Indiana University. List two contributions he made to the profession of dentistry.

Outline

I. Purpose of Dental Radiography

A. Only preoperative means of inspecting the hidden structures of oral cavity

B. Qualities of diagnostic radiographs

1. Proper contrast
2. Proper density
3. Maximal definition
4. Minimal distortion
5. Outline the anatomy of region under consideration

C. Definition of radiography

1. Art and practice of making radiographs
    a. Practice
    b. Study
    c. Experience
    d. Judgment
2. Science - embodies
    a. Physics
    b. Mathematics
    c. Chemistry

D. Practitioners responsibilities

1. Produce acceptable radiographs
2. Determine errors and correct them
3. Practice correct radiation safety
4. Manage dental patients
5. Demonstrate a knowledge of physics, chem, math.

II. History

A. Mechanism

1. 1870-1895 vacuum tube experimentation
2. Pioneers
    a. Hittorf
    b. Goldstein
    c. Crookes

B. Discovery

1. November 8, 1895
2. Wilhelm Conrad Roentgen, Professor of Physics & Director of the Physical Institute University of Wurzburg
3. Incidental discovery during experimentation with fluorescence
4. First roentgenogram of his wife's hand

C. Early pioneers

1. 1896 Dr. Otto Walkhoff first dental roentgenogram ever made (used 25 minutes exposure)
2. Dr. Morton, New York physician first dental roentgenogram in America 1896
3. Dr. Edmund Kells, New Orleans
    a. First dentist to use small films in the mouth
    b. Damaged by prolonged exposures
    c. Committed suicide

D. History of dental x-ray film

1. Emulsion made on a glass plate enclosed in black paper and rubber dam
2. Later flexible celluloid used as film base
    a. Temperamental
    b. Dangerous - highly flammable, explosive
3. Eastman Kodak Company - first pre-packaged intraoral film

E. History of intraoral roentgenographic technics

1. Ciesznski, Polish engineer, 1907 bisection of angle technic
2. Howard Raper
    a. Refined bisection technic
    b. Average projection angles
    c. Further refined by Simpson
3. Dr. Franklin McCormack British Medical Radiologist
    a. Paralleling technic 1920
    b. 5-6 feet target distance

4. Dr. Gordon Fitzgerald
    a. 1940 University of California
    b. Developed and introduced paralleling intraoral technic
5. Other leaders in paralleling
    a. Dr. Waggener, University of Nebraska
    b. Dr. Updegrave, Temple University "XCP"
    c. Dr. Arthur Wuehrmann, Alabama University

F. Development of dental radiology - Howard Raper
1. First text
2. First full-time course in a dental college (Indiana)
3. 1924 invented bitewing

X-Ray Generation Equipment

Objectives

1. **Describe the components of the x-ray head and the purpose of each.**
2. **Name the component parts of the x-ray tube.**
3. **List the three types of transformers and state the function of each.**
4. **List four types of cones used on dental x-ray machines.**
5. **Name the material used for filtration and describe it's function.**
6. **Explain the purpose of the lead diaphragm.**
7. **List two factors controlled by kilovoltage.**
8. **List two factors controlled by the miliamperage.**
9. **Describe the functions of the timer.**

Outline

I. Terminology

A. Radiology: Science of ionizing radiation, encompassing radioactive materials as well as x-rays, used in diagnosis and treatment of disease.

B. Roentgenology: Science of x-rays, taking and interpreting pictures, used in treatment of disease. (Terms are synonymous)

II. Basic Radiographic Equipment

A. Head of x-ray machines: houses radiation production equipment, cone, angle meter

B. X-ray tube: anode and cathode in vacuum

C. Transformer: carries the electrical charge to the tube

D. Oil container: outside sealed compartment of anode and cathode, cools heat generated

III. Components of Equipment

A. X-ray tube

1. Outer lead glass vacuumed envelope
2. Anode
    a. Positive charge
    b. Copper with tungsten target (focal spot)
3. Cathode
    a. Negative charge
    b. Tungsten filament in molybdenum focusing cup
4. Production of radiation
    a. Transformers: alternates current
    b. Types and function
        i. Step-up transformer: high voltage to drive electrons to target.

ii. Step-down transformer: reduces voltage and increases current to heat filament.

iii. Autotransformer: adjusts voltage to allow variable settings on the machine.

B. X-ray cone

1. Short
2. Long
3. Plastic
4. Lead-lined: entire cone acts as a collimator
5. Metal

C. X-ray filter: aluminum disc

1. Inherent, added, total filtration
2. Filters out the long wave lengths, increases penetration

D. Collimator: lead diaphragm

1. Absorbs all x-rays except size of opening
2. Restricts CR to a straight, narrow path
3. Reduces secondary radiation

E. Controls

1. Kilovoltage
    a. Controls the penetration of the radiation (short wave length, high energy)
    b. Contrast: increases as KV decreases (gradation of opaque, gray, blacks)
2. Miliamperage
    a. Controls the rate of energy production, number of electrons
    b. Density: degree of overall blackness
3. Timer exposure
    a. Helps limit "under" or "over" exposure
    b. Activates current to produce radiation
    c. Electronic timer
        i. 60 cycle impulses
        ii. Consistent

Radiographic Film, Cassettes and Intensifying Screens

Objectives

1. List the contents of an intraoral film package and describe the purpose of each part.

2. Describe the composition of the radiographic film itself.

3. Explain the usage of the following intraoral radiographs:

- **a. Periapical**
- **b. Bitewing**
- **c. Occlusal**

4. Name three types of Extra-oral radiographs.

5. Detail the construction of an intensifying screen.

6. Describe the construction of a cassette and its usage in dentistry.

7. List five methods of proper care of unexposed radiographic film.

Outline

I. Radiographic Film

A. Packaging

1. Outer paper wrappings / Plastic outer wrappings
2. Inner paper wrapping
3. Lead foil backing
4. Radiographic film

B. Radiographic film construction

1. Silver coating emulsion
2. Gelatin emulsion - silver bromide suspended in gelatin
3. Radiographic base acetate - cellulose or polyester and is usually tinted blue

C. Types of radiographic film

1. Intraoral films
   a. Periapicals - Type 2 and Type O
   b. Bitewings - Type 2 and Type O
   c. Occlusals
2. Extraoral Films
   a. 5" x 7" lateral jaw
   b. 8" x 10" head plates and TMJ views
   c. 5" x 12" panoramic

II. Extraoral Film Holder

A. Intensifying screens

1. Thin layer of tiny fluorescent calcium tungstate coated on a white lacquer surface of cardboard or plastic.

2. X-rays cause calcium tungstate to emit bluish light with varied intensity.

3. Film contact important

4. Requires much less radiation

5. Vary in speed - thicker larger crystals faster

B. Cassette

1. Two intensifying screens enclosed in a metal frame

2. Used mostly in extra-oral radiography

III. Handling of Unexposed Film

A. Deteriorates with age

B. Moisture and heat induce deterioration

C. White light sensitive

D. Protect from x-radiation to avoid fogging

E. Handle carefully

1. Extra-oral cassette loading

2. Handling errors

a. Scratch emulsion

b. Finger prints

c. Static electricity

d. Solution contamination

Darkroom Film Processing and the Chemicals Involved in Processing

Objectives

1. List eight items needed in a well equipped dental darkroom.

2. List the chemical components of the developer solution and explain the function of each during the developing process.

3. List the chemical contents of the fixer solution and explain the role of each in fixation of the radiograph.

4. Describe the latent image.

5. Name four possible reasons why film may become fogged.

6. State the two factors altered in automatic processors.

7. Describe the process of lightening dental radiographs.

Outline

I. Equipping a Dental Radiographic Darkroom

A. Water temperature control unit

B. Tanks for developer and fixer inserted into water bath

C. Timer clock

D. Film racks - Periapical and extra-oral

E. Solution mixers

F. Safelights

G. Film mounting board

H. Dryer is optional - can use an electric fan

II. Processing Solutions

A. Developer solution

1. Organic reducing agents

a. Metol (or elon) acts during early development stage. Produces gray image.

b. Hydroquinone - acts more slowly. It builds up density and contrast to the desired levels.

2. Preservative- sodium sulfite

a. Protects the organic reducing agents from oxidation.

b. Prolongs the effective life of the developer.

3. Accelerator - sodium carbonate or sodium hydroxide.

a. Swells the emulsion slightly allowing the developer to act.

b. Provides an alkaline medium for the hydroquinone to act, speeding the developing process.

4. Restrainer - potassium bromide

a. Holds back any action of the developer on the unexposed silver bromide grains without preventing the action of the developer on the exposed grains.

b. Inhibits fogging of the lighter areas without interfering with image development.

5. Optimum developing time

6. Replenisher solution for developer

a. Replaces oxidized hydroquinone and metol.

b. Always thoroughly stir the developer after replenisher is added.

c. Properly maintained, the developer can last for two or three months.

B. Rinsing films

1. Immerse films in running water, ridding them of developer chemicals.

2. Reduces contamination of fixer with developer.

3. If rinsing is not thorough, the fixer does not act evenly and streaking occurs.

C. Fixing solution

1. Fixing agent

a. Sodium thiosulfate clears the film.

b. Dissolves the unexposed, underdeveloped silver bromide.

c. Leaves metallic silver in the exposed or developed areas of the film.

2. Preservative - sodium sulfite

a. Protects sodium thiosulfate from decomposition.

b. Helps clear the film.

3. Hardener - chrome alum or potassium alum

a. Hardens the gelatin in the emulsion.

b. Protects film from scratches.

4. Acid - sulfuric or acetic

a. Neutralizes the alkali remaining on the film.

b. Provides an optimum medium for the fixer and hardener.

5. Optimum fixing time - too long may cause browning of image or even bleaching.

6. Rinsing and final fixing

7. Fixer replenishment - loss is due to film being carried out of tank on racks and film, and evaporation.

D. Drying - either air dry or use warm air dryers.

E. Proper cleaning of processing tanks.

III. Standard Manual Film Processing Technique

A. All areas must be dry and clean.

B. Check temperature of developer (optimum temperature should run 68°F to 72°F) with immersed thermometer.

C. Set timer clock at proper developing time but don't start it.

D. Shut all doors excluding all white light. Safelights are the only lights on.

E. Open each film packet and place on the proper clip of the film rack.

F. After placing all films on rack immerse in developer, agitate gently. Make sure no films overlap or touch other film.

G. Start timer clock.

H. When time clock rings, lift film from developer rapidly and immerse and agitate in water wash bath for 15 seconds.

I. Place film in fixer and agitate for 10 seconds.

J. Leave in fixer for 3 minutes when using small size film. Up to 5 minutes for larger film.

K. Wash films in water wash and bring out to viewing area.

L. After films have been initially viewed then they are given a final fixing in the fixer solution for a minimum of 10 minutes.

M. They are then placed in final water wash for about 20 to 30 minutes.

N. Then dry films.

IV. Latent Image Production

A. Silver bromide film emulsion

B. Electro - chemical change occurs when x-ray energy strikes the film.

C. Image becomes visible upon darkroom processing.

V. Darkroom Errors - Common Film Defects

A. Fog - generalized graying of film.

1. Exposure to light

a. White light leaks.

b. Safelight contains wrong bulb

c Safelight filter is cracked

d. Safelight filter is incorrect

e. Film exposed by prolonged contact with safelight

f. Four feet from safelight to working area

2. Exposure to radiation or radioactive elements

a. Shield films

b. Use a lead-lined container or place films at a distance

3. Chemical fog

a. Over development

b. Development at too high temperature

c. Oxidized or deteriorated developer

d. Prolonged or repeated inspection of films during development

e. Contamination accumulation in tanks

4. Age fog

a. Out dated films

b. Improper storage.

i. Heat

ii. Humidity

B. Stains

1. Various discolorations of films at different intervals of time after processing.

2. Can be avoided by using fresh solutions and correct processing.

a. Brown - oxidized developer

b. Variable color pattern - inadequate rinsing

c. Grayish - yellow or brown - excessive fixation, or use of exhausted fixer

d. Grayish - white scum - incomplete washing

e. Spotty shiny brown discoloration - silver tarnish

C. Marks and defects

1. Crinkle marks - bends

2. Static marks - tree-like black marks. Static electricity. Open film gently.

3. Water marks - water droplets leave round spots of various sizes.

4. Cassette marks - dark particles, paper, hair screen defects leave corresponding white spots on the film.

5. Reticulation marks - network of fine grooves in film surface caused by marked differences in the temperatures of processing solutions.

6. Streaked appearance - to avoid:

a. Agitate films in developer

b. Rinse films adequately

c. Agitate films when placed in fix

d. Stir processing solutions thoroughly after replenishment

e. Adequately wash film hangers after use in fixer

VI. Automatic Film Processing

A. Increased concentration of solutions to decrease processing time.

B. Increased processing temperatures speed processing.

1. 80 - 84°F developer

2. 75°F fixer and wash

3. 95 - 115°F in dryer

C. In developer, aldehydes are added to combat film fog.

D. Emulsion hardener - added to developer

E. Control of emulsion thickness - carbonates in developer control swelling of emulsion

F. Precise replenishment of developer and fixer

VII. Lightening Radiographs

A. Chemicals

1. Sodium thiosulfate
2. Potassium ferricyanide
3. Equal portions mixed

B. Chemicals remove some metallic silver from image, making films lighter.

C. Fix immediately after reduction.

Nature and Behavior of Radiation

Objectives

1. **List five types of electromagnetic radiation.**
2. **Define the terms wavelength and frequency in your own words.**
3. **Discuss six properties specific to roentgen rays.**
4. **Name three types of corpuscular or particulate radiation.**
5. **Describe the two types of energy transfer:**
    a. **particulate (corpuscular)**
    b. **electromagnetic (non-corpuscular)**
6. **List the steps of energy transfer in the production of radiation.**

Outline

I. Electromagnetic Radiation

A. Roentgen rays - radiant energy similar to light waves

B. Examples of electromagnetic radiation (non-corpuscular, non-particulate)

1. Radio waves - audible
2. Light waves - visible tight
3. Infra-red waves
4. Ultra-violet rays (sun)
5. X-rays - man-made in x-ray tubes
6. Gamma rays - atomic bomb - natural substances - like radium
7. Cosmic rays - space - most penetrating

C. Properties

1. No mass (weight) or electrical charge (neutral)
2. Travel in straight lines
3. Travel in a wave motion
    a. Wavelength - distance between the crest of one wave to the next
    b. Frequency - number vibrations (crest rise and fall) per second
    c. Long wave length
        i. Radar
        ii. Television - 1-5 yards
        iii. Radio - football field
    d. Short wave length - (A° = 1/100,000,000 cm)
        i. Visible light 3,800 - 8,000 A°
        ii. X-radiation 0.1 A° - 0.5 A°

D. Properties of x-rays

l. Invisible and weightless

2. Travel in straight lines

3. Travel at speed of light

4. Extremely short wavelength

5. Able to penetrate substances

6. Absorbed differentially by matter

7. Cause substances to fluoresce

8. Affect film emulsion producing a latent image

9. Cause biologic changes

II. Corpuscular Radiation (Particulate)

A. Definition - minute particles of matter that:

1. Travel in straight lines at high speed from their sources

2. Small but have mass

3. Charged electrically (except neutrons)

4. Examples

a. Cathode rays

b. Alpha or beta particles of radium

c. Protons and neutrons from the splitting of atoms

B. Fundamental Concept Of Matter

1. Atom

a. Nucleus

i. Protons

ii. Neutrons

iii. Bound together by force

b. Electrons orbit around nucleus

2. Orbits - definite energy levels of electrons

a. K, L, M, N, O

b. K - activity for x-ray production

3. X-ray production

a. Electrons dislodge one or more orbital electrons of the atom

b. K electron moves out of orbit L orbit electron falls into place

c. Releases energy in form of x-ray photon

4. X-ray photon - conversion of kinetic energy (speeding electrons) into radiant energy.

a. Electron stopped by a collision with the tungsten atom which results in radiation

b. Glancing collisions which result in less energy release in form of heat

5. Energy conversion steps

a. Electric energy

b. Kinetic energy

c. X-ray energy and heat

Generation of X-rays

Objectives

1. Define ionization.

2. Describe the chain of events in the production of radiation.

3. Compare the characteristics of "hard x-rays" to the characteristics of "soft x-rays."

Outline

I. Essential requirements

A. Electrons

B. Generating system to impart speed to the electrons

C. Matter - which is the target

II. Mechanism

A. Separation of electrons from atoms - set free from the atoms contained in the tungsten filament by the action of heat, controlled by step-down transformer.

B. Giving them high-speed - high voltage is applied to secure high speed travel of electrons, supplied by step-up transformer.

C. Concentrating on a small area - electrons are guided to anode target.

D. Stopping them with sufficient suddenness - only metals with a high melting point can be used as a barrier.

1. Generation of heat at the surface of impact

2. Generation of invisible radiant energy in the form of electromagnetic waves

III. Energy Exchange

A. Kinetic energy - electrons in motion

B. Electrons are stopped by hitting atoms in the target, they are decelerated losing some or all of their kinetic energy.

1. Energy cannot be destroyed

2. Transferred into other forms or wavelengths

a. Heat

b. X-rays

C. X-Ray Production

1. Cathode electron dislodges a K electron

2. Nucleus binding force pulls an L electron into K orbit (ionization - addition or removal of orbital electron)

3. Electron acquires kinetic energy in motion from L to K

4. Upon coming to rest in K orbit it releases a wavelength characteristic of tungsten

5. Several forms of deceleration occur and produce varying wavelengths

IV. Types of X-rays

A. Hard x-rays

1. Relatively high frequency
2. Short wavelengths
3. High penetrating power
4. Production
    a. High kilovoltage
    b. Al filter - screens out less penetrating rays

B. Soft x-rays

1. Low frequency
2. Long wavelength
3. Low penetrating power
4. Production
    a. Lower kilovoltage
    b. Lighter filtration

Geometry of Radiographic Image Formation and Quality of Radiographs

Objectives

1. List the visual and geometric characteristics of radiographs.

2. Define in your own words the following terms:

- **a. Density**
- **b. Contrast: long-scale and short-scale**
- **c. Focal-film distance**
- **d. Object-film distance**

3. Discuss the controlling factors in:

- **a. Density**
- **b. Contrast**
- **c. Definition**
- **d. Magnification**

4. Describe three ways of producing a sharp image.

Outline

I. Visual - Observed Illumination of the Finished Radiograph, Image Produced by Selective Absorption of X-rays.

A. Density - blackness resulting from the deposition of metallic silver

1. Radiolucent - x-rays freely pass through - appear dark
2. Radiopaque - x-rays are absorbed and only partially pass through object
3. Degree of density
    a. High density - dark film
    b. Low density - light film
4. Controlling factors
    a. Exposure technic
        i. Milliamperage and exposure time are interchangeable (2 sec. at 10 MA same density as 4 sec. at 5 MA end product is equal to 20 MAS)
        ii. The higher the MAS, the more x-rays shower the films and the greater the quantity of metallic silver deposited
    b. Kilovoltage
        i. The higher the KV, the shorter the wavelength and resulting penetration.
        ii. More radiation strikes the film and a greater quantity of metallic silver is deposited - higher density.
5. Focal-film distance
    a. The smaller the distance between the focal spot and the film, the more x-rays strike the film.

b. Inverse square law

$$\frac{I_1}{I_2} = \frac{(D_2)^2}{(D_1)^2}$$

where I_1 and I_2 are intensities at distances D_1 and D_2, respectively.

B. Contrast - x-rays are absorbed differently by various tissues of the body resulting in differing silver deposition - appearing black, gray, white. The difference in density between the light and dark areas on a radiograph is known as contrast.

1. Scale - affected by kilovoltage
    a. Long scale - higher KV, greater penetration and gradations of density
    b. Short scale - lower KV, greater differences in adjacent structures
2. Relationship of contrast / density
    a. KV increase, MA decreases to maintain density
    b. Higher the MA, the lower the voltage, greater contrast
3. Primary factors in contrast and density for diagnostic film
    a. Lead diaphragm - reduces secondary radiation and fog
    b. Filters - also reduces fog by screening out longer wavelength rays
    c. Film - speed and age
    d. Proper darkroom procedures
    e. Thickness and nature of object

II. Geometric Characteristics

A. Definition - sharpness of structure lines or minute details in a radiograph. Three factors affecting radiographic definition

1. Geometry
2. Motion
3. Screens

B. Unsharpness

1. Geometric
    a. Smaller the focal spot, the sharper the definition 0.8 mm to 1.5 mm square.
    b. Improved when the focal spot film distance is increased.
    c. The shorter the object-film distance, the sharper the image.
2. Motion
    a. Patient
    b. Film
    c. Head of x-ray machine
3. Screen

a. Intensifying screen crystal size and film contact.

b. Higher definition achieved with slow (small crystal) screen and longer exposure.

c. Use non-screen film

C. Magnification

1. Focal spot size (controlled by manufacturer).
2. Focal spot-film distance as long as possible.
3. Object-film distance - as short as possible.

D. Distortion

1. Improper alignment of film.
2. Incorrect projection.
3. Reduced in parallelism.

Radiation Biology I

Objectives

1. **List the three possible reactions of x-radiation with matter.**
2. **Briefly outline the ionization of a tissue atom.**
3. **Name the two types of effects that radiation has on humans.**
4. **List four types of radiation exposure that will produce somatic effects.**
5. **Discuss three factors which alter the effect of radiation exposure.**

Outline

I. Nature of X-radiation - High Speed Photons with No Electrical Charge

A. Reaction with matter

1. Passes through tissue without changing anything

2. Nuclei of atoms in tissue are sometimes hit and energy deflected. This deflection continues until the energy is gone.

3. Photons hit orbiting electrons of tissue atoms and dislodge them: photoelectric recoil effect.

B. Ionization of tissue atoms - molecular alterations and creation of new chemicals.

1. Tissue - composed of atoms arranged in a particular pattern known as molecules which are electrically stable.

2. Radiation - when x-ray strikes an electron in a molecule of living tissue it:

a. Displaces an electron.

b. Leaves molecule electrically unbalanced or ionized.

3. Ionized atom

a. Positive charge attracts an electron from somewhere else to become stable.

b. Cell becomes altered.

C. Human body composed of infinite numbers of molecules each with a complex system of atoms.

1. Living tissue largely filled with spaces thus allowing the passage of radiation.

2. Should radiation strike a tissue cell, it probably wouldn't destroy the cell.

3. Destruction of a single cell wouldn't have an observable damaging effect.

II. Radiation Effects

A. Somatic - include all cells of the body other than the reproductive cells - evident in radiation exposed biologic systems.

1. Examples: erythema, dermatitis, blood changes, ulcerations, cancer, sterility, shorten lifespan, death.

2. Resulting from:

a. Large radiation amounts to the whole body (acute exposure rapid radiation delivery over a short period of time).

b. Large radiation amounts to limited body areas (acute or chronic).

c. Small radiation amounts to whole body (chronic - repeated doses over a long period of time).

d. Small radiation amounts to limited body areas (acute and chronic).

B. Genetic - changes in chromosomes and mutations of genes in sex cells

1. Changed genes with altered hereditary pattern are passed on to succeeding generations.

2. Low dose levels have been established below the level of microscopic or macroscopic visual alterations.

III. Factors in Radiation Exposure Effects.

A. Tissue variability - some tissues are more susceptible to ionizing radiation. The following tissues are listed from the most radiosensitive to the least radiosensitive:

1. Blood forming tissue and reproductive cells

2. Young bone, gland tissue and epithelium of the alimentary canal

3. Skin and muscle

4. Nerve tissue and adult bone

B. Portion of body exposed

1. Whole body dose - effect on the entire organism increases with the number of cells exposed to radiation.

2. Localized dose - radiation is directed toward a specific area of a living organism.

C. Individual variability - certain individuals have a greater ability to tolerate and recover from radiation exposure.

IV. Dosage Terminology

A. Roentgen (R) x-radiation measurement - amount of ionization in a specific volume of air.

B. Rad - roentgen absorbed dose - absorbed dose per gram of absorbing material.

C. Rem - roentgen equivalent man - indicates the extent of biologic injury.

D. RBE - relative biologic effectiveness-ability to produce biologic effects; certain types of radiation are more effective than others.

E. l R = l RAD = l REM.

Radiation Biology II

Objectives

1. List the order of cell sensitivity from the most sensitive to the least sensitive.

2. Define the following terms:

- **a. Latent period of radiation**
- **b. Accumulative effect of radiation**
- **c. Maximum permissible dose**

3. Relate the level of exposure to the resulting damage that would result from large amounts of radiation to the whole body.

4. Describe four types of injuries induced when damaging amounts of radiation are received by human tissue.

5. Discuss the importance of shielding the reproductive organs during exposure to radiation.

Outline

I. Tissue Reaction

A. Type of cells

1. Rapidly dividing or regenerating cells.
2. Radiosensitive group.
    a. Reproductive cells
    b. Blood-forming tissues
    c. Lymphatic tissue
    d. Young bone tissue
    e. Skin and gland
3. Radioresistant group.
    a. Connective tissue
    b. Muscle tissue
    c. Nerve tissue
    d. Mature bone tissue

B. Influence of time: latent period of radiation

1. Time lapse before any effects are seen.
2. Time range.
    a. Acute - minutes, days, weeks
    b. Long-term - years, decades, generation
    c. Generally - the larger the dose, the earlier the appearance of injury

C. Accumulative effects of x-radiation

1. The effects are accumulative, not an accumulation of x-rays in the tissue.

2. Whatever the dose, there will be repair to damaged tissues as long as complete degeneration has not occurred.

3. Biologic effects are carried in the nucleus.

4. Chromosomes sometimes are damaged.

    a. Repair

    b. Repair incompletely

    c. Repair haphazardly which may alter the pattern

    d. Cell could die

5. The healing process

    a. Replacement of damaged tissues

    b. Recuperation of injured cells

    c. Residual damage from which no recovery occurs

6. Residual damage without recovery is the accumulative effect of radiation.

II. Radiation Effects

A. Somatic

1. Large amounts of radiation to the whole body.

    a. Atomic explosion or nuclear energy accident

    b. Amounts and effects:

        i. 0 - 25 R - no observable effect

        ii. 25 - 50 R - possible blood cell changes, no ;injury apparent

        iii. 50 - lOO R - blood cell changes, some injury, no disability

        iv. 100 - 200 R - injury, possible disability

        v. 200 - 400 R - injury and disability certain, death probable

        vi. 400 R - fatal to 50% of exposed group

        vii. 600 R or more - fatal

2. Large amounts, limited area (acute and chronic)

    a. Radiation therapy in treatment of malignant tumors

        i. 2,000 - 6,000 R may be tolerated in a local area with only reversible acute reactions and moderate late changes.

        ii. Malignant cells are destroyed and regeneration of the surrounding healthy cells occurs.

    b. Acute exposure, 200-500R

        i. Temporary sterility

        ii. Temporary erythema

        iii. Hair loss - epilation

iv. Depression of blood-forming cells

3. Small amounts of radiation to whole body

a. Chronic - type of radiation we all receive from natural background and occupational hazards.

b. Maximum permissible limits for radiation workers

1. 1.25 R whole body dose / per calendar quarter (year total of 5 R)

2. Defined as the radiation exposure not expected to cause appreciable bodily injury to a person at any time during his life.

4. Small amounts of radiation, limited area

a. Biologic effect not likely to be critical.

b. Hazard increases with repeated dose or where large amount or sensitive tissues are exposed.

c. No rationale for a dental operator to hold films in patients mouths during radiation exposure.

B. Genetic

1. Effects of x-radiation upon the reproductive cells are similar to other cells:

a. Breaking of chromosomes

b. Production of genetic mutations

2. Important to shield reproductive organs during radiation exposure with a lead apron.

III. Additional Information

A. Damaging amounts of radiation to tissue may result in:

1. Erythema - redness of the skin due to congestion of the blood capillaries. Threshold dose for human skin - 250R.

2. Chronic dermatitis - inflammation of the skin.

3. Atrophy of the skin with epilation - dryness and breakdown of the skin with loss of hair.

4. Collagen becomes hyalinized - breakdown of the main supportive protein of skin, tendon, bone, cartilage and connective tissue.

5. Immature blood cells - are damaged.

6. Small blood vessels - are destroyed.

7. Ulcers form

8. Osteoradionecrosis - usually occurs from an overdose of radiation during radiotherapy. The tissues exhibit varying degrees of damage and the ability to resist trauma and infection. When it does occur the treatment is removal of the destroyed tissue or a resection of the bone.

9. Mutations with neoplastic activity - long term effects of radiation as a result of altered cell production.

B. Cell sensitivity

1. Radiosensitive

a. Reproductive cells

b. Blood forming cells

c. Lymph cells

d. Young bone cells

e. Skin and gland cells

2. Radioresistant

a. Connective cells

b. Mature bone cells

c. Nerve cells

d. Muscle cells

Radiation Safety, Control And Hygiene

Objectives

1. **Describe three sources of radiation in the dental office.**
2. **State all the proper procedures for protecting the operator from radiation.**
3. **Discuss six methods of protecting the patient from radiation.**
4. **Identify the proper type of cone suitable for proper radiation hygienic operation.**
5. **Discuss the necessity for radiographs with the dental patient.**

Outline

I. Sources of Radiation in a Dental Office

A. Primary radiation

B. Leakage radiation

C. Secondary radiation

II. Radiation Shielding

A. Barriers

B. Protective aprons

III. Procedures for Protecting Operator

A. Avoid primary beam and scatter radiation - use lead barrier or be 6 feet from radiation source.

B. Never hold the film during exposure

C. Never hold the tube/cone

D. Use properly operating equipment and regularly test for leakage

E. Use film badge service

IV. Procedures for Protecting the Patient

A. High speed films

B. Use of lead-lined open-end cones to reduce scatter/secondary radiation

C. Filtration with aluminum

D. Lead apron protection

E. Use film locating instruments

F. Correct technique with minimum of retakes

G. Proper processing to avoid re-exposure from incorrect processing

H. Avoid exposing the pregnant patient

V. Reducing Radiation Fears of Patients Concerning Radiographs

A. Essential for adequate oral diagnosis

B. Differentiate between amount of radiation needed to produce dental x-rays and that used in other medical procedures.

C. Provide examples that are of equivalent risk.

Technique Theory and Common Errors in Technique and Film Processing

Objectives

1. Define the following terms:

- **a. horizontal angulation**
- **b. vertical angulation**
- **c. central ray**

2. Differentiate between:

- **a. positive vertical angle and**
- **b. negative vertical angle**

3. Demonstrate the bisecting angle theory by a simple drawing. (Label the tooth, film, bisecting angle, vertical cone angle).

4. Describe the relationship of the film, tooth, and cone in the paralleling technique.

5. Compare the bisecting angle technique to the paralleling technique, including advantages and disadvantages of both.

6. Discuss five anatomic limitations of the patient's oral cavity which would make taking radiographs difficult.

7. Discuss the two types of vertical dimensional distortion: elongation and foreshortening. How would the operator correct these errors?

8. Identify and discuss the correction of all the technique and processing errors listed on pages X and Y in this manual.

Outline

I. Terminology

- A. Film placement
- B. Central ray
- C. Vertical angle
  1. Positive
  2. Negative
- D. Horizontal angle
- E. Long axis of the teeth
- F. Parallel
- G. Bisecting angle

II. Techniques

- A. Five rules for accurate image formation
  1. The distance between the source of radiation and the object should be as great as practical.
  2. The film should be as close as possible to the object being radiographed.
  3. The central ray should be as perpendicular to the film as possible.

4. The long axis of the object should be parallel to the film.
5. The focal spot should be as small as possible.

B. Paralleling technique

1. Relationship of cone, tooth,film
2. Advantages
    a. Truest image formed because central ray perpendicular
    b. Easier to reproduce a nearly identical film for comparison in diagnosis.
    c. Decreases magnification of the image (follows principle of source to object.)
    d. Easier to estimate angle because of 1 evaluation factor long axis of tooth
3. Disadvantage - anatomic limitations
    a. Tori
    b. Shallow palate
    c. Shallow floor of mouth
    d. Short lingual attachment
    e. Narrow or crowded arch
    f. Multiple missing teeth

C. Bisecting angle

1. Relationship of cone, tooth, bisecting angle and film
2. Image distortion
    a. Elongation
    b. Foreshortening
3. Advantages
    a. Alternative for patient with anatomic limitations
    b. Film closer to object
    c. Requires limited equipment
    d. Provides distortion principle for modifying paralleling technique to accommodate patients mouths.
        i. Children
        ii. Edentulous ridge
4. Disadvantages
    a. Short source to object distance which prevents optimum detail.
    b. Object and film not parallel so CR not perpendicular to object and film simultaneously.
    c. The operator must evaluate three factors to produce a proper image:
        i. Long axis of tooth
        ii. Film plane

iii. Bisecting angle

d. Produces image with greater distortion

D. Both have limitations

1. Both acceptable in dentistry

2. Parallel technique is preferable

III. Technical Errors

A. Technique errors in vertical dimension

1. Elongation

2. Foreshortening

B. Technique errors in horizontal dimension

C. Cone placement errors

D. Film placement errors

1. Backwards

2. Improper positioning

3. Double exposure

E. Improper folding of film

F. Movement

1. Patient

2. Cone

G. Exposure

IV. Technical Errors In Processing

A. Solution contamination of films

1. Developer

2. Fixer

3. Moisture

4. Fluoride

B. Improper processing

1. Reticulation

2. Film underdeveloped

3. Film overdeveloped

4. Film placed in fixer first

5. Film removed from fixer too soon

C. Film handling

1. Films left stuck together during processing

2. Static electricity
3. Fingerprint

Radiographic Anatomic Landmarks Of The Maxilla And Mandible

Objectives

The student will be able to identify the following maxillary radiographic landmarks on intraoral radiographs.

1. **Maxillary tuberosity**
2. **Lateral pterygoid plate**
3. **Hamular notch**
4. **Hamulus**
5. **Maxillary sinus**
6. **Zygomatic arch and zygomatic process**
7. **Naso-labial fold**
8. **Inverted "Y"**
9. **Nasal fossa**
10. **Soft tissue shadows**
    a. **lip**
    b. **nose**
11. **Nasal septum**
12. **Incisive foramen**
13. **Mid-palatine suture**
14. **Anterior nasal spine**
15. **Lamina dura**
16. **Nutrient canal**
17. **Radioluciencies in maxillary sinus**
18. **Coronoid process**

The student will be able to identify the following mandibular anatomic land

marks on intraoral radiographs.

1. **External oblique ridge**
2. **Internal oblique or mylohyoid ridge**
3. **Submandibular fossa**
4. **Mandibular canal**
5. **Lower border of the mandible**
6. **Mental foramen**
7. **Mental ridge**
8. **Soft tissue of the lip**
9. **Lingual foramen**
10. **Genial tubercle**
11. **Mental ridge**
12. **Trabecular pattern of bone**

Further Objectives:

1. **Define the terms radiolucent and radiopaque.**

2. Classify the radiographic appearance of the anatomic landmarks of the maxilla and mandible into radiopaque and radiolucent categories.

3. Discuss the possible landmarks observable on a radiograph of the maxillary molar area.

4. Differentiate between the appearance of the zygoma and the zygomatic process.

5. Distinguish between the maxillary sinus and the nasal fossa.

6. Discriminate between the soft tissue outlines and the boney anatomy in the maxilla and the mandible.

7. Name and describe the anatomic landmarks of the maxillary incisor area.

8. Discuss the location and appearance of the major foramina observable on intraoral periapicals.

9. Discuss the positional relationship of the landmarks of the mandibular molar area.

10. Discuss the landmarks that would be found on a radiograph of the mandibular incisors.

11. Discuss the relationship of the landmarks that comprise the inverted "Y".

12. Recognize the radiographic appearance of the following: lamina dura, nutrient canals, normal trabeculation.

Outline

I. Review Concepts

A. Differential absorption of x-rays by matter

B. Terminology

1. Radiolucent
2. Radiopaque

II. Landmarks of the Maxilla

A. Molar area

1. Maxillary tuberosity
2. Lateral pterygoid plate
3. Hamular notch
4. Hamulus
5. Maxillary sinus posterior wall
6. Zygomatic process
7. Zygoma

B. Bicuspid area

1. Maxillary sinus (medial and anterior)
2. Zygoma
3. Naso-labial fold

C. Cuspid

1. Inverted "Y"

a. Maxillary sinus (anterior border)

b. Nasal fossa

2. Soft tissue shadows

a. Lip

b. Nose

D. Incisor area

1. Nasal fossa
2. Nasal septum
3. Incisive foramen
4. Mid-palatine suture
5 Anterior nasal spine

E. Other radiographic entities

1. Lamina dura
2. Nutrient canal
3. Nerve and blood vessel depressions in maxillary sinus
4. Coronoid process
5. Septum in sinus
6. Trabecular pattern

III. Landmarks of the Mandible

A. General anatomy

1. Ramus
2. Condyle
3. Lingual ridge
4. Mental ridge

B. Molar area

1. External oblique ridge
2. Internal oblique ridge (Mylohyoid)
3. Submandibular fossa
4. Mandibular canal
5. Lower border of the mandible

C. Bicuspid area

1. Mental foramen
2. Landmarks extending anteriorly from molar area

D. Cuspid area

1. Soft tissue - lip line
2. Lower border of mandible

E. Incisor area

1. Lingual foramen
2. Genial tubercle
3. Lower border of mandible
4. Mental ridge
5. Lip line

Radiographic Interpretation

Objectives

Interpretation of Tooth Structure and Associated Entities - The student will be able to identify the following structures on dental radiographs.

1. **Primary teeth**
2. **Developing permanent teeth**
3. **Impacted teeth**
4. **Supernumerary teeth**
5. **Occlusal caries**
6. **Interproximal caries**
7. **Calculus deposits**
8. **Bone loss**
9. **Bone fracture**
10. **Root resorption**
11. **Enamel hypoplasia**
12. **Bone repair**
13. **Periapical lesion**
14. **Retained root tips**

Interpretation of Dental Restorations and Restorative Materials - The student will be able to identify the following materials and restorations on dental radiographs.

1. **Amalgam and gold restorations**
2. **Porcelain teeth and pontics**
3. **Cement base**
4. **Resin restorations and teeth**
5. **Gold post and core**
6. **Bridges**
7. **Endodontically treated teeth**
8. **Orthodontic bands**
9. **Lingual arch wires**
10. **Space maintainers**

Further Objectives

1. **Describe the radiographic appearance of developing teeth.**
2. **Differentiate between the radiographic appearance of normal tooth structure and caries activity.**
3. **Compare the radiographic appearance of hypoplastic enamel and normal enamel.**
4. **Describe the appearance of a tooth with root resorption as observed on a radiograph.**
5. **Provide a description of the radiographic appearance of calculus.**
6. **Discuss the radiographic conditions that you might observe given a full mouth series of a patient with severe tooth decay.**
7. **Differentiate between the radiographic appearance of a metallic restoration and a cement base.**

8. Describe the radiographic appearance of porcelain.

9. Distinguish between the radiographic appearance of a resin restoration and a carious lesion.

10. Recognize the radiographic appearance of: endodontically treated teeth, space maintenance appliances, post & core and bridge replacement of tooth structure.

Outline

I. Normal Radiographic Appearance of Teeth

A. Permanent teeth

B. Primary teeth

C. Developing permanent teeth

D. Impacted teeth

E. Supernumerary teeth

II. Disease Processes

A. Caries

1. Occlusal
2. Proximal
3. Degree

B. Periodontal disease

1. Calculus
2. Bone loss

C. Periapical pathology

D. Bone pathology

III. Other Processes or Entities

A. Bone fractures

B. Root resorption

C. Enamel hypoplasia

D. Bone repair

E. Retained root tips

IV. Dental Restorations and Restorative Materials

A. Alloy, gold restorations

B. Porcelain

1. Pontics
2. Denture teeth
3. Crown

C. Cement bases and temporary restorative materials

D. Resin

1. Restorations
2. Teeth

E. Gold post and core

F. Bridges

G. Endodontic treatments

H. Stainless steel crowns

V. Other Appliances

A. Orthodontic bands

B. Lingual arch

C. Space maintainers

1. Band and loop
2. Distal shoe

Mounting Of Dental Radiographs

Objectives

Given a full mouth set of radiographs and a mount, the student will be able to:

1. Label the mount clearly and neatly with the patient's name and the date the radiographs were taken.

2. Orient the films with the convexity toward the operator.

3. Using the appearance of anatomic landmarks and the morphology of the teeth as guides, divide the films into the following groups:

a. Maxillary periapicals

b. Bitewings

c. Mandibular periapicals

4. Lay out the films in the order indicated by the mount pattern (facing the mount as if it were the patient's oral cavity).

5. Place each radiograph into the proper position in the mount.

6. Evaluate the mounted radiographs for accuracy using the following checks:

a. All convexities facing the operator

b. Natural progression and arrangement of teeth

c. Maxillary and mandibular arches are mounted with respect to identifying anatomic landmarks and morphological appearance of teeth.

d. Bitewing radiographs correlate with the adjacent periapicals

e. Logical appearance of the curve of spee

Outline

I. Introduction

A. Mounted display of radiographs

1. Demonstrates value of radiographs to patient
2. Tangible product of your services
3. Organizes charting and examination procedures
4. Displays a normal relationship of teeth and surrounding anatomy
5. Reduces the handling of individual films
6. Provides a permanent record for identification and comparison

B. Identification dot (the convexity)

1. Indicates the side of film toward the source of radiation
2. Helps determine right from left

II. Anatomic Landmarks

A. Maxilla

1. Coronoid process of mandible
2. Zygoma
3. Sinus

4. Inverted "Y"
5. Nasal fossae
6. Nasal septum
7. Incisive foramen

B. Bitewings

1. Curve of Spee
2. Logical progression of teeth
3. Match restorations with maxillary and mandibular periapicals

C. Mandible

1. External oblique ridge
2. Mandibular canal space
3. Mental foramen
4. Mental ridge
5. Lingual foramen

D. Tooth morphology

III. Procedure

A. Assemble necessary materials

1. Film mounts
2. View box or an illuminator
3. Pen or labels
4. Clean and dry working surface

B. Orient all films with convexity up

C. Separate film into groups

1. Maxillary
2. Bitewings
3. Mandibular

D. Lay out films in the order of the mount

E. Insert films carefully into mount

IV. Checks

A. Natural progression and arrangement of teeth

B. Convexities toward operator

C. Anatomic landmarks in the appropriate areas

D. Position and shape of restorations in bitewings coincide with periapicals

E. Logical appearance of the Curve of Spee

GLOSSARY

Absorption - The process by which radiation imparts some or all of its energy to any material through which it passes. (See also Compton Effect, Photoelectric Effect, and Pair Production.)

Added Filtration - The filtration (whether aluminum, copper, or lead) placed in the X-ray beam to absorb preferentially the less penetrating radiations.

Anode - The positive electrode within an X-ray tube toward which electrons from the cathode are accelerated. The kinetic energy possessed by the high-speed electrons is converted to heat and X-rays when the electrons strike the anode. It is usually made of tungsten metal.

Attenuation - The process by which a beam of radiation is reduced in intensity when passing through some material. It is a combination of absorption and scattering processes and leads to a decrease in density of the beam.

Backscattering - The deflection of radiation by scattering processes through angles greater than 90 degrees with respect to the original direction of motion.

Barriers, Primary Protective - Barrier sufficient to attenuate the useful beam to the required degree.

Barriers, Protective - Barrier of attenuating material used to reduce radiation hazards.

Barriers, Secondary Protective - Barrier sufficient to attenuate the stray radiation to the required degree.

Beam (X-ray) - A unidirectional or approximately parallel flow of electromagnetic rays (X-rays).

Cathode - A negative electrode in an X-ray tube where electrons are produced. It consists of one or two filaments and focusing cups.

Cephalometric Radiography - Lateral and posterio-anterio head films used in orthodontics and to a lesser extent in prosthodontics. Usually a five foot distance is used between the focal spot and the midline of the patients head.

Characteristic Radiation - Radiation from a target material with an energy spectrum characteristic of the energy state of the orbital electrons in the target atoms.

Collimator, Diaphragm - Terms used interchangeably to refer to devices or mechanisms by which the X-ray beam is restricted in size.

Compton Effect - An attenuation process observed for X or gamma radiation in which an incident photon interacts with an orbital electron of an atom to produce a recoil electron and a scattered photon of energy less than the incident photon.

Cone Distance - Refers to the distance between the focal spot and the outer end of the cone usually expressed in inches or centimeters. Modern dental X-ray units usually have a cone distance of 7 inches.

Cones - Restrict the beam of X radiation to the immediate part of the object under examination and thus minimize the secondary radiation by limiting the volume of the exposed area. The result is increased contrast, which makes radiographic detail more plainly visible.

Definition (Detail) - In radiology, definition (or detail) refers to the sharpness of structure lines or contour lines on the processed film. Definition (detail) depends upon (1) size of the focal spot, (2) geometry, (3) filtration, (4) motion, (5) grain size of screens, (6) grain size of film, (7) emulsion thickness of film, (8) processing solutions, and (9) processing technics.

Diaphragms - Usually lead discs with openings of various sizes and shapes. The diaphragm limits the size of the primary beam to the area of interest minimizing patient exposure to the primary beam and materially reducing the amount of secondary radiation.

Dosage - The radiation delivered to a specified area of the body. Units for dose specification for X-rays are roentgens. In radiology, the dose may be specified in air or at the surface of the skin. No statement of dose is complete without specifying the location.

Dose, Absorbed - The quantity of energy imparted to a mass of material exposed to radiation. The unit of absorbed dose is the rad.

Dose, Exposure - A measure of X or gamma radiation based upon its ability to produce ionization in air. The unit of exposure dose is the roentgen.

Dose RBE - The unit of RBE dose is the rem, which is that dose having a biological effect equivalent to that of one rad of X or gamma radiation of a given energy (about 250 Kev). Numerically, the dose in rems equals the dose in rads times the RBE. (Relative Biological Effectiveness)

Dosage Rate - Dose per unit time.

Dosimeter - Instrument used to detect and measure an accumulated dosage of radiation; in common usage, it is a pencil size ionization chamber with a built-in self-reading electrometer used for personnel monitoring.

Effective Wavelength - Wavelength of monochromatic X-rays which would undergo the same percentage attenuation in a specified filter as the heterogeneous beam under consideration.

Electron - Negatively charged particle which is a constituent of every neutral atom. Unit of negative electricity equals to 4.8 x]o-l° electrostatic units or 1.6 x 10-19 coulombs. Its mass is 1/1845 of an atomic mass unit.

Filament - The filament of an X-ray tube is a coiled tungsten wire which when heated to incandescence emits electrons. The temperature of the wire, and hence the rate of emission of electrons, is controlled by a low voltage heating current in a process termed thermionic emission. The filament is a part of the cathode.

Film Badge - Appropriately packaged photographic film worn on a person and used for approximate measurement of radiation exposure for personnel monitoring purposes. The badge may contain two or three films of differing sensitivity, and it may contain a filter which shields part of the film from certain types of radiation.

Focal Spot - That portion of the target which is struck by the electron beam.

Fog - Fog refers to the generalized darkening of a processed X-ray film. It may result from (1) exposure to white light in the darkroom, (2) from a crack in the safe-light housing or filter, (3) a faded or incorrect filter in the safe-light, (4) too large a bulb in the safe-light, (5) too long exposure to the safe-light, or (6) exposure to radiation. Chemical fogging can occur from use of deteriorated developer or old porous developer tanks which retain chemicals in their walls.

Grenz Rays - X-rays produced at voltages of 5 to 20 kv.

Hard X-rays - Hard X-rays are X-rays of high penetrating power.

HVL (Half-Value Layer) - The half-value is the thickness of a specified material (usually aluminum, copper or lead) required to decrease the dosage rate of a beam of X-rays to one-half its initial value.

Inherent Filtration - Refers to the filtration effect of the materials (such as glass and oil) making up the wall of the X-ray tube.

Intraoral Radiographs - Are those made by placing a film packet inside the mouth and projecting the X-radiation from a position on the outside of the mouth at various angles to the region under survey and to the film.

Ion - Atomic particle, atom, or chemical radical bearing an electrical charge, either negative or positive.

Ionization - The process or the result of any process by which a neutral atom or molecule acquires either a positive or a negative charge.

Ion Pair - Two particles of opposite charge, usually referring to the electron and positive atomic or molecular residue resulting after the interaction of ionizing radiation with the orbital electrons of atoms.

Kilovolt (kv) - 1000 volts; refers to the quality of penetration of the X-radiation.

Kilovolts Peaks (kvp) - The crest value of the potential wave in kilovolts. When only one-half of the wave is used, the value refers to that of the useful half of the wave.

Leakage (Direct) Radiation - The radiation which escapes through the protective shielding of the X-ray unit tube head. This radiation is detected at the sides, top, bottom or back of the tube head.

Maximum Permissible Dose (MPD) - (Radiation Protection Guides): Dose of ionizing radiation that, in the light of present knowledge, is not expected to cause detectable bodily injury to the average person at any time during his lifetime.

Milliampere-Second (mas) - The numerical product of the milliamperage multiplied by the number of seconds. With all other factors being held constant, the film density is related to the mas; and the density will remain constant even though the ma, and the seconds of time are varied, so long as they vary reciprocally and their product remains unchanged.

Oral Radiographic Examinations - Complete set of radiographs depicting shadow images of all the tissues, structures, and regions of the oral cavity, its adjacent areas and associated parts, or it may consist of one or more roentgenograms of any region of interest.

Oral Radiography - Name given to the specialized operative and technical procedures and practices for making successful radiographic examinations.

Oral Radiology - All phases of the science and art of radiology that are of interest to the dental profession. It also includes the interpretation of diagnostic radiographs and the application of roentgen rays for therapeutic purposes.

Production - An absorption process for X and gamma radiation in which the incident photon is annihilated in the vicinity of the nucleus of the absorbing atom with subsequent production of an electron and positron pair. This reaction only occurs for incident photon energies exceeding 1.02 Mev.

Periapical Radiographs - Radiographs made for recording shadow images of the outlines, position, and mesiodistal extent of the teeth and their surrounding tissues. The periapical radiograph is the best means available whereby the apices of the teeth and their contiguous tissues are disclosed.

Personnel Monitoring - A systematic periodic check of the radiation dose each person receives during his working hours.

Phantom - A phantom is a device that absorbs and scatters X-ray in approximately the same way as the tissues of the body. It may be made of a balloon full of water, a set of Masonite or Presdwood sheets, a sack of rice, a coconut or other similar substances. Readings taken without a patient or phantom in the examining position are meaningless for personnel protection purposes because they do not take into account the effect of the patient's body in scattering radiation throughout the room.

Photoelectric Effect - A process by which a photon ejects an electron from an atom. All the energy of the photon is absorbed in ejecting the electron and in imparting kinetic energy to it.

Physics, Health - A term in common use for that branch of radiological science dealing with the protection of personnel from harmful effects of ionizing radiation.

Primary Radiation (direct radiation) - The useful beam of X-radiation that emanates directly from the focal spot.

Projection - A term for the position of a part of the patient with relation to the X-ray film.

Quality - Refers in a general way to the penetrating power of an X-ray beam. Soft X-rays possess low penetrating power. Hard X-rays possess high penetrating power.

RAD (Radiation Absorbed Dose) - Unit of absorbed dose, that is, energy absorbed by material such as tissue. One rad is 100 ergs per gram. With X-rays, one roentgen of exposure will usually produce about one rad of absorbed dose in soft tissue.

Radiation - The emission and propagation of energy through space or through a material medium in the form of waves; for instance, the emission and propagation of electromagnetic waves.

Radiation (Stray) - Radiation not serving any useful purpose. It includes direct radiation and secondary radiation from irradiated objects.

Radiation Field - The region in which energy is being propagated.

Radiation Hazard - The hazard that exists in any area to which a person has access while X-ray equipment is in operation and the dosage rate is greater than the permissible dosage rate.

Radiation Hygiene - The art and science of protecting human beings from injury by radiation. Since any amount of radiation is harmful in some degree, the ideal objective is to prevent the exposure of any person without a definite purpose.

Radiation Survey - A critical examination of the radiation near an installation by or under the supervision of a qualified expert in radiation hygiene.

Radiography - Generally considered synonymous with roentgenography (photography by means of X-rays).

Radiolucent - An entity which appears dark on a radiograph. One in which little radiation absorption takes place.

Radiopaque - An entity which appears white on a radiograph. One in which there has been radiation absorption to a greater extent thus leaving a white image on the film.

Radiosensitivity - Relative susceptibility of cells, tissues, organs, organisms, or any substances to the injurious action of radiation. Radio-resistance and radio-susceptibility are at present employed in a comparative sense rather than in an absolute one.

Relative Biological Effectiveness (RBE) - The ratio of gamma or X-ray dose to the dose that is required to produce the same biological effect by the radiation in question.

Roentgen - The quantity of X or gamma radiation such that the associated corpuscular emission per 0.001293 grams of air produces, in air, ions carrying one electrostatic unit of quantity of electricity of either sign.

Roentgen Dermatitis - Dermatitis caused by exposure to X-rays

Roentgenography - (Radiography - skiagraphy - actionography) The science and art of generating and applying the roentgen rays for the purpose of making shadow pictures known as roentgenograms (radiographs). New term is radiography.

Roentgenology - (Radiology - skialogy) The study and use of the X-ray in its application to medicine and dentistry. New term is radiology.

Roentgen Rays - X-rays.

Scattering (Scattered Radiation) - Change of direction of a photon as a result of a collision or interaction.

Secondary Radiation - Radiation emitted by any matter being irradiated with X-rays.

Soft X-rays - Soft X-rays are X-rays of low penetrating power.

Speed - The term speed in radiology is used to refer to the relative amount of darkening produced on a film from a given amount of radiation. This may also refer to speed of the film.

Spectrum - A visual display, a photographic record or a plot of the distribution of the intensity of radiation of a given kind as a function of its wavelength, energy, frequency, momentum, mass or any related quantity.

Target - That part of the anode which faces the cathode and is bombarded by the high speed electrons.

Target Angle - The target angle is the angle away from perpendicular at which the electron stream from the cathode strikes the anode target.

Target Film Distance - The distance from the X-ray tube target (anode) to the x-ray film.

Target Skin Distance (TSD) - The distance from the X-ray tube target (anode) to the skin of the patient where the X-ray beam enters his body.

Total Filtration - Refers to the total filtration of the X-ray beam provided by both the inherent filtration and the added filtration.

Tube - Usually refers to the glass tube within the head of the X-ray unit wherein X-rays are produced as a result of high-speed electrons striking a metallic target (anode).

Useful Beam - That part of the primary radiation which passes through the aperture, cone, or other collimator.

Wavelength - Distance between any two similar points of two consecutive waves.

X-rays (Roentgen Rays) - X-rays are a form of radiant energy of the electromagnetic spectrum possessing the speed of light. X-rays have extremely small wavelengths (in some cases within the dimensions of atoms), and are capable of passing through materials that are opaque to ordinary light. X-rays result from extra-nuclear interactions within atoms.

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